

FINAL REPORT

**A REVIEW AND ASSESSMENT OF VIRGINIA'S LICENSE PLATE SHEETING
SPECIFICATIONS**

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(A Cooperative Organization Sponsored Jointly
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and the University of Virginia)

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EXECUTIVE SUMMARY

At the request of Virginia's Secretary of Transportation, the Virginia Transportation Research Council undertook a review and assessment of the Virginia Department of Transportation's license plate sheeting specifications. This review was focused on five test methods or specifications recently called into question:

1. cold temperature resistance
2. solvent resistance
3. gasoline resistance
4. International Organization for Standardization (ISO) 9002 registration
5. directional warranty mark.

A review was undertaken of the license specifications of eight other states: Wisconsin, California, North Carolina, Ohio, New Jersey, Washington, Pennsylvania, and Texas. In addition, several consensus-based specifications were identified as having relevance to the testing of reflective materials. These included Federal Specification L-S-300C, various American Society of Testing and Materials (ASTM) specifications, and an ISO specification.

In addition to these reviews, meetings were held with representatives from Avery-Dennison, 3M Company, the Virginia State Police, the Virginia Department of Motor Vehicles, and the Virginia Department of Corrections so that each party's interests and concerns could be understood.

The review revealed that a number of changes had occurred regarding how reflective sheeting has been specified. One significant change was that an ASTM specification superseded the federal specification in the late 1980s. However, the ASTM specification did not, and likely will not, include all of the test methods contained in the federal specification. Virginia's license plate sheeting specifications should continue to reference the federal specification, when required, until such time other consensus-based specifications can be updated.

As a result of the assessment, the Virginia Transportation Research Council recommends several changes to the license plate sheeting contract specifications. The following is an overview of the proposed changes:

- *Cold temperature resistance:*
 - Separate the impact test from the cold temperature resistance test.
 - Modify the current cold temperature resistance test to one that is more indicative of the temperature conditions a license plate may experience in Virginia.

- Add a resistance to heat test that is indicative of the temperature conditions found in Virginia.
- *Solvent resistance:* Reduce the submersion time requirement for toluene, xylene, and methyl alcohol from 2 minutes to 1 minute.
- *Gasoline resistance:* Maintain a gasoline resistance test but modify the current test method to one that is more representative of how license plates might be exposed to gasoline.
- *ISO 9002 registration:* Modify the specification to allow Six Sigma to be an equal alternative to the ISO registration requirement.
- *Directional warranty mark:*
 - Continue to require an integral warranty/security mark that is indelible for the life of the license plate.
 - Retain the current warranty/security mark design.
 - Encourage the development and implementation of a consistent training course for Virginia’s law enforcement community on the warranty/security mark found in Virginia’s license plates.
 - Hold a one-day workshop with the Virginia State Police, the Virginia Sheriffs’ Association, and the Virginia Association of Chiefs of Police to determine how the warranty/security mark should function and to discuss and develop performance requirements to be used in future product development and specifications.

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INTRODUCTION

At the request of Virginia's Secretary of Transportation, the Virginia Transportation Research Council undertook a review and assessment of Virginia's license plate sheeting specifications. The review was focused on five test methods or specifications recently called into question:

1. cold temperature resistance
2. solvent resistance
3. gasoline resistance
4. International Organization for Standardization (ISO) 9002 registration
5. directional warranty mark.

METHODS

License plate specifications from eight other states were reviewed: California, New Jersey, North Carolina, Ohio, Pennsylvania, Texas, Washington, and Wisconsin. In addition, several consensus-based specifications were identified as being relevant to the testing of reflective materials. These included Federal Specification L-S-300C, various American Society of Testing and Materials (ASTM) specifications (<http://www.astm.org>), and an ISO specification (<http://www.iso.ch/iso/en/ISOOnline.openerpage>).

In addition to these reviews, meetings were held with representatives from Avery-Dennison, 3M Company, the Virginia State Police, the Virginia Department of Motor Vehicles, and the Virginia Department of Corrections to identify each party's interests and concerns.

RESULTS

Cold Temperature Resistance

Since Virginia’s cold temperature resistance test is a combined impact and cold temperature resistance test, the following test methods were reviewed for impact and temperature resistance test methods: eight state specifications, Federal Specification L-S-300C, ASTM D 4956-01a, and ISO 7591. Table 1 is a summary of the consensus specification test methods, and Table 2 is a summary of the state test methods reviewed.

Table 1. Summary of Consensus Specification Test Methods

Specification	Impact			Temperature	
	Force	Impact Zone	Evaluation	Heat	Cold
Fed. Spec. L-S-300C	10 in-lb	Front	Outside impact area	160°F for 24 hr	-70°F for 72 hr
ASTM D 4956	10 in-lb	Front	Outside impact area	No test required	
ISO 7591	No weight specified	Front	Outside impact area	Cycle (150°F for 7 hr, 73°F for 1 hr, -4°F for 15 hr)	

Table 2. Summary of State Test Method Specifics

State	Impact		Temperature		Combined Test Methods
	Method	Force	Heat	Cold	
Pennsylvania	ASTM	10 in-lb	130°F for 24 hr	-30°F for 72 hr	No
North Carolina	ASTM	10 in-lb	No Test Required		No
California	No test required		200°F	-10°F	No
Texas	No test required		3 cycles (150°F for 1 hr, 30°F for 1 hr, room temp.)		No
Wisconsin	State	72 in-lb	No test required	0°F for 6 hr	Yes
Virginia	State	40 in-lb	No test required	0°F for 12 hr	Yes

Consensus Specifications

Impact Resistance

Federal Specification L-S-300C, ASTM D 4956-01a, and ISO 7591 all have test methods for impact resistance. The ISO specification is the only one that requires the sample panel to be conditioned below freezing prior to impact testing.

Both Federal Specification L-S-300C and ASTM D 4956 require the test panel to be impacted using the same weight object with the same force (10 in-lb). The weight of the steel ball in the ISO specification was not specified. All three test methods require the sheeting side of the panel to be impacted and evaluated. The performance requirement for these tests is that the sheeting must not show any cracking or delamination outside the actual area of impact.

Temperature Resistance

Federal Specification L-S-300C and the ISO 7591 specifications have test methods for heat and cold separate from those for impact testing. The ISO specification requires the samples to be tested through a cycle of temperatures, whereas the federal specification has separate tests for heat and cold. After the testing, the material should have no evidence of cracking, peeling, chipping, or delamination from the test panel.

State Specifications

As Table 2 shows, there is no consistent approach to the state specifications for impact tests, temperature resistance tests, and a combined impact-temperature test. Only one other state, Wisconsin, was identified as having a combined impact and cold temperature resistance test method.

North Carolina and Pennsylvania

These two states use the ASTM D 4956 impact test method without modification. Pennsylvania requires that the material be tested for resistance to temperature using requirements similar to those in Federal Specification L-S-300C.

California

California's requirements for temperature resistance are somewhat different than those of the other states reviewed. For the cold tolerance, a lower maximum temperature is specified but not the time for which the panel must be exposed to this temperature.

California also requires that the sheeting be resistant to heat and permit force curing at temperatures up to 200°F. Again, no length of time of exposure is specified.

Texas

Texas was the only state reviewed that required sheeting to be exposed to cyclic temperature changes. The finished license plates are required to be exposed to temperatures ranging from 30°F to 150°F in three consecutive cycles.

Wisconsin

Wisconsin's test method for cold temperature resistance is similar to that of Virginia. Wisconsin, however, requires that the impact force be considerably greater and the exposure to 0°F be for only 6 hours; Virginia requires 12 hours at the same temperature.

Wisconsin indicated that they experience severe weather conditions and that license plates are often subjected to impacts from other vehicles and debris on the roadway. Their test method was designed to determine the ability of the reflective sheeting materials to withstand impact under cold conditions.

Cold Temperature Test Failures

In 1999, Wisconsin awarded their license plate sheeting contract to Avery Dennison, who was the lowest responsible bidder, after both 3M's and Avery Dennison's sheeting failed the cold temperature resistance test. The 3M Company protested the award and requested that the contract be re-advertised since both manufacturers failed the test. In January 2000, Wisconsin's Secretary of Administration denied 3M's request for several reasons, including the fact that "department of transportation personnel were unable to identify a single customer complaint of product failure due to cold-weather impact." Wisconsin concluded that the test method did not evaluate these products under conditions that were reasonably expected to be encountered during normal service life. Further, Wisconsin recommended that the cold weather resistance test not be considered critical to the overall evaluation.

In lieu of the cold weather test method specified, Wisconsin exposed samples of finished plates at -70°F for 3 days. They found that none of the plates from either manufacturer showed any evidence of breakdown or fading. Based on the exposure test results, Wisconsin concluded that both products would provide satisfactory cold-weather performance.

Discussion

As previously discussed, there is no consistent approach to the state specifications for impact tests, temperature resistance tests, and the combined impact-temperature tests.

Wisconsin's experience has shown that the combined test method is arbitrary and does not evaluate materials with regard to how they will perform while in service.

Recommendation

Based on the information and specifications reviewed, there appears to be an opportunity to separate the impact test from the cold temperature resistance test without adversely affecting the durability of the license plate sheeting Virginia is procuring. Virginia should consider revising the cold temperature specification to include a separate impact test and a temperature resistant test. Modifying the testing protocol to include resistance to heat and cold will allow officials to better evaluate a material's potential performance under climatic conditions more relevant to Virginia's.

Proposed Revision

6. *Impact Resistance*

- a. *The reflective sheeting, when applied to the license plate substrate per III.A.2, shall show no evidence of cracking, pitting, blistering, edge lifting, or curling when tested with an impact apparatus such as a Gardner Model IG-1120 Impact Tester fitted with a 2 lbs. standard weight and dropped from a height necessary to generate an impact of 10 in-lbs.*
- b. *The panel shall be tested from the front side (sheeting side) only. The impact panel striker shall have a hemispherical head radius of 5/8 inch. The panel support is a 0.64 inch cylindrical hole centered under the striker for supporting the panel.*

New Provision (Adopted from Federal Specification L-S-300C and Pennsylvania's Specification)

Temperature Resistance

Resistance to Heat – A sample specimen of 3 inches by 6 inches shall be used for this test. Three samples shall be tested. Each specimen shall be exposed in an oven at 130 degrees F (+/- 5 degrees F) for 24 hours, removed and conditioned at standard conditions for 2 hours, and evaluated. The specimen shall show no evidence of cracking, peeling, chipping, blistering, edge lifting, or curling.

Resistance to Cold – A sample specimen of 3 inches by 6 inches shall be used for this test. Three samples shall be tested. Each specimen shall be exposed to an air temperature of -30 degrees F (+/- 5 degrees F) for 72 hours, removed and conditioned at standard conditions for 2 hours, and evaluated. The specimen shall show no evidence of cracking, peeling, chipping, blistering, edge lifting, or curling.

Temperature values were adopted from the Pennsylvania test method. Temperature ranges are closer to Virginia's extreme temperature variations.

Solvent Resistance

Eight state specifications, one federal specification, and ASTM specifications were reviewed for solvent resistance test methods. Five states and Federal Specification L-S-300C were identified as having a solvent resistance test method.

Specifications

Wisconsin and Federal Specification L-S-300C

Wisconsin requires that license plate panels be sufficiently solvent resistant in accordance with Federal Specification L-S-300C. The sample sizes, solvents, and submersion time requirements are identical for both specifications with one exception: Wisconsin requires materials to be tested using mineral spirits rather than kerosene.

Both specifications require the material to be air dried and then examined for any wrinkling, puckering, blistering, or edge lifting. If any failure occurs, the lot of materials is rejected.

Pennsylvania

Pennsylvania uses only a portion of Federal Specification L-S-300C, in that they test for solvent resistance using kerosene and turpentine for 10 minutes. They do not require that materials be tested with toluene, xylene, and/or methyl alcohol. Pennsylvania requires that the exposed materials show no evidence of puckering, blistering, or dissolving of the exterior film.

New Jersey and Washington

These two states have less rigid solvent resistance specifications and use more subjective evaluations. They require license plates to be exposed to VM&P naphtha, mineral spirits, turpentine, or other solvents commonly used on vehicle finishes. Their specifications do not indicate the solvent to which the license plates are to be exposed or for how long they are to be exposed.

The method used for evaluating the resistance to these solvents is just as subjective. Both specifications require that the "plate surface shall show no appreciable change following cleaning."

Texas

Texas uses a different set of chemicals and exposure time requirements than any of the other states or the federal specification. They require that license plates be exposed for 15 minutes to a sodium chloride solution and mineral spirits (ASTM D 235).

Texas requires that the completed license plates show no apparent change in color or retroreflectivity after exposure.

Recommendation

Based on the information and specifications reviewed, there appears to be no reason to exceed the specifications of the federal test method at this time. It is therefore recommended that the submersion time requirement for toluene, xylene, and methyl alcohol be modified from 2 minutes to 1 minute as follows:

7. *Solvent Resistance*
 - a. *License plate panels prepared per III.A.2 shall be sufficiently solvent resistant to withstand exposure to mineral spirits, turpentine, toluene, xylene, and methyl alcohol in accordance with Fed. Spec. LS-300C without wrinkling, puckering, or edge lifting.*
 - b. *Test panels shall be 1" x 6" strips cut from license plate blanks. Strips of the license plate shall be exposed as follows: mineral spirits and turpentine—submerged in a container with 4" of solvent for 10 minutes. Toluene, xylene, and methyl alcohol—submerged in a container with 4" of solvent for 1 minute.*
 - c. *Samples shall be allowed to dry and be examined for any wrinkling, puckering, blistering, or edge lifting. Failure of samples shall be cause for rejections.*

Gasoline Resistance

Eight state specifications and the ISO 7591:1982 standard for license plate sheeting were reviewed. Pennsylvania and California were the only two states that had explicit test methods for determining resistance to gasoline. Two other states, New Jersey and Washington, and the ISO standard had performance requirements using a reference fuel to simulate gasoline.

Specifications and Standards

Pennsylvania

Virginia's specification for gasoline resistance was adopted directly from the Commonwealth of Pennsylvania's specifications for reflective sheeting for license plates. The Pennsylvania Department of Transportation's (PennDOT) gasoline resistance specification was developed in the late 1960s when the gasoline fill pipes were located at the rear of vehicles behind the license plate (L. Shebosky, personal communication, May 28, 2003). The test method specified was developed since a significant amount of gasoline was spilled onto license plates. Today, however, PennDOT recognizes that the test method is obsolete. This is because vehicle characteristics have changed (e.g., fill pipes are no longer located behind the license plate) and the test takes too long, is hazardous and messy, and in general serves no purpose in today's environment. Pennsylvania will be modernizing their test method for the next license plate sheeting contract in 2008.

California

California's test requires that the finished license plate be immersed in a commercially available unleaded gasoline for 1 minute and then allowed to air dry. Once dry, the reflective sheeting and process inks are inspected for any evidence of dulling; whitening; softening; blistering; crinkling; or dissolving of the exterior film, inks, and adhesive or their separation from the substrate.

New Jersey and Washington

These two states require that finished license plates be immersed for 1 minute in a test fuel (ASTM D 471, Reference Fuel B) and that the test panel not show any visible change that would reduce its effective performance.

ISO 7591:1982 Standard

This standard requires that a portion of the sample-finished license plate, including letters, be immersed for one minute in a test fuel (of similar composition as the ASTM D 471, Reference Fuel B) and that the test panel not show any visible change that would reduce its effective performance.

Discussion

The Virginia and Pennsylvania test method of using a buret and dripping gasoline at a 20-degree angle while using a radiant sun lamp presents significant hazards to those running the test. It is also unclear how this test predicts the performance of a material under real-world conditions.

The California, New Jersey, and Washington specifications and the ISO 7591 standard, although slightly less hazardous, do represent a test method that is more indicative of how a license plate could be exposed to gasoline. However, all four test methods present issues that should be considered:

- California requires a commercially available unleaded gasoline; no octane or grade is indicated.
- Gasoline is a mixture that will vary depending on its source, refining process, and the geographic location where it is to be consumed.
- Reference Fuel B (ASTM D 471) is a blend of two chemicals that is used to simulate the effects of gasoline in a more standardized approach; i.e., reference fuels can be produced consistently many times over.

Recommendation

There remains a likelihood that license plates will come into contact with gasoline, either by accidental exposure or through gasoline being used as a cleaning agent. Since there remains the potential exposure to gasoline, maintaining a gasoline resistance test is recommended. It is, however, recommended that the current specification be modified as follows to be more representative of how license plates may be exposed to this chemical:

9. Gasoline Resistance

- d. Graphic license plate panels prepared per III.A.2 shall be sufficiently gasoline resistant to withstand exposure to gasoline when tested in accordance with the following procedure. The reflective material and process inks shall show no evidence of dulling, whitening, softening, puckering, blistering, crinkling, or dissolving of the exterior film, inks, or adhesive, or separation from the substrate.*
- e. A fully prepared license plate shall be immersed in a commercially available unleaded gasoline for a period of one minute. After removal from the gasoline the specimen will be air dried.*

Modifying the test method would make it more representative of how a license plate might be exposed to gasoline and the result of such exposure. Based on material testing by other states, both 3M and Avery Dennison can comply with this proposed specification.

ISO 9002 Registration Requirement

In determining whether it is reasonable to remove the ISO 9002 registration requirement from the Commonwealth of Virginia's license plate sheeting specifications, background information on the ISO and other quality management systems was reviewed.

Specifications

International Organization for Standardization

The ISO 9000 family of standards is known worldwide as being generic management system standards. In this case, "generic" means that the same set of standards can be applied to any organization, no matter what the product. The "management system" component refers to what the organization does to manage its process.

In December 2000, the ISO 9001, ISO 9002, and ISO 9003 standards were integrated into a new standard: ISO 9001:2000. This new standard provides specific requirements for an organization to demonstrate its ability to provide a product consistently that meets customer needs and any applicable regulatory requirements. The end goal of this standard is to enhance customer satisfaction.

Six Sigma

Six Sigma is another quality management system that is widely accepted in industry and manufacturing. It is a business improvement strategy that seeks to identify, reduce, and eliminate defects from every product, process, and transaction. Six Sigma requires the organization or company to define its process and identify, collect, and analyze data in order to reduce variation. Basically, it is a method of conducting business in which the company or organization is focused on defect prevention through the use of statistical tools rather than through inspection.

Six Sigma prohibits having more than 3.4 defects per million opportunities (99.9997% perfect) in any process, product, or service. Six Sigma is also a systematic, disciplined, and quantitative approach to continuous improvement. This quality management system uses its analytical evaluations to focus on waste, operating cost, cycle time, profitability, and customer satisfaction.

Discussion

Other quality management systems are being used in other areas of manufacturing. Each system, whether it is the ISO 9001:2000 standard, Six Sigma, or another management system, varies in the method to arrive at the final product, and some are more analytically driven than

others. Regardless of the system, each is a business approach focused on providing quality products/services to meet customer needs.

Recommendation

Recognizing that the Commonwealth of Virginia is the ultimate customer for the final product (license plate sheeting and roll coat inks) and there is the need for high-quality, defect-free material to be supplied, it is reasonable to require bidders to certify that they have a quality management system in place. It is, however, not reasonable to require a bidder to be ISO 9001:2000-registered when similar quality management systems are being used worldwide for similar products.

Therefore, it is recommended that the license plate specification language be modified as follows to allow at least Six Sigma be an equal alternate to the ISO registration:

- 2. Bidders shall certify that all license plate sheeting and roll coat inks purchased by the state are covered by the manufacturer's plant ISO 9001:2000 registration or Six Sigma independent certification.*

It is further recommended that the state consider requiring an independent certification for the Six Sigma process.

Directional Warranty Mark

Eight state specifications were reviewed and interviews were held with representatives from Avery Dennison, the 3M Company, the Virginia Department of Motor Vehicles (DMV), the Virginia State Police (VSP), and the Virginia Department of Corrections (DOC) to gather information concerning directional warranty marks. Five of the eight states have requirements for an identification or registry mark.

Standards and Specifications

Ohio

Ohio requires the manufacturer of license plate sheeting to provide a registry mark for use in the manufacturing process. The mark may or may not be an integral part of the finished plate. The directional functionality of the mark and whether it may detract from or interfere with the aesthetics of the finished plate are not addressed.

New Jersey, North Carolina, and Washington

Washington requires a registry mark and an identification mark, whereas New Jersey and North Carolina require only an identification mark. The registry mark may or may not be an integral part of the finished license plate.

The identification mark requirements for the three states are similar. All require that the mark be an integral part of the sheeting to make unauthorized plate reproduction difficult. The mark must be visible on a finished plate under laboratory or field conditions and must be verifiable in diffuse daylight and by retroreflective light at night. Further, these states require that the mark not alter the sheeting colors or graphic design or reduce sheeting brightness.

Texas

Texas requires that license plate sheeting be marked so as to be traceable to the specific manufacturer's production run. Texas was the only state reviewed that had the same functional directional warranty mark requirements as Virginia (i.e., not visible from 2 feet to 20 feet or when the observer steps to one side from head-on).

Discussion

After the review of the other state specifications and the discussions with 3M, Avery Dennison, and state representatives, it was concluded that Virginia is using, and requires, a warranty mark for two purposes: (1) to control inventory and identify lots in the event of a material failure so that warranty provisions can be exercised, and (2) to ensure the security and identification/verification of authentic license plates.

Inventory Control and Lot Identification

In a meeting with representatives from DMV, DOC, and VSP, DOC provided an overview of how the warranty mark is used and its importance in lot identification. DOC enumerated the requirements for their purposes. These requirements included the need for the mark to be an integral part of the sheeting and to be indelible for the life of the license plate. The current process of having alphanumeric codes for lot identification is the most effective method of managing the warranty provisions. Avery Dennison indicated that they are capable of producing indelible alphanumeric codes in sheeting but that the manufacturing process to do so increases the costs to the customer.

Identification/Verification of Authentic License Plates

All parties in the process agreed that security against counterfeit license plates has been a concern and is an even greater concern in today's climate. Everyone agreed that license plates

should have an easily identifiable warranty/security so that public safety officials can quickly determine their authenticity. At issue, however, is the functionality of the warranty/security mark. From the specifications reviewed, only Texas and Virginia provide explicit requirements regarding when and where the warranty mark must be visible (and not visible).

Avery Dennison indicated that the manufacturing process to produce the directional warranty mark is restricted by the 3M Company's patent (No. 4,634,220). The patent will expire January 6, 2004, which would allow competitors to produce directional warranty marks as currently specified. However, the current performance requirements specified, i.e., that the warranty mark not be visible at 2 or 20 feet or when the observer steps to one side, may or may not be the requirements needed by law enforcement agencies in Virginia.

Questions also arose concerning whether the existence of the warranty/security mark in license plates is widely known and what training concerning the mark is provided to law enforcement agencies. The representative from VSP indicated that the warranty/security mark feature has recently been added to VSP training, but it is unclear whether official training is provided to the local law enforcement communities.

Other Issues

According to DMV records, Virginia has issued approximately 6.8 million pairs of license plates having the current warranty/security mark feature. Consistency in the design of the warranty/security mark is important to ensure that public safety officials can easily authenticate license plates. Changing the design with more than 6.8 million pairs of license plates in use would place two types of warranty/security marks in the field, thus increasing the difficulty of authenticating a license plate.

According to a representative from Avery Dennison, the current design used by Virginia can be manufactured but it would not have the directional feature currently required. Even with the 3M patent expiring, Avery Dennison will not produce warranty/security marks in license plate sheeting having the same directional requirements because of the extensive development and equipment upgrades required to do so.

Recommendations

Based on the state specifications reviewed, discussions with all parties, and recognition that more than 6.8 million pairs of license plates are currently in service with the warranty/security mark feature, the following is recommended:

- Virginia should continue to require an integral warranty/security mark that is indelible for the life of the license plate. Further, this warranty/security mark design should not be changed from the one being used today.

- The Virginia State Police should work the Virginia Sheriffs' Association, the Virginia Association of Chiefs of Police, and other law enforcement agencies operating in Virginia to develop and implement consistent training concerning the warranty/security mark across all levels of law enforcement in Virginia to take full advantage of the security feature currently in place.
- The Virginia State Police should consider holding a one-day workshop with the Virginia Sheriffs' Association, the Virginia Association of Chiefs of Police, and other law enforcement agencies operating in Virginia to discuss how the warranty/security mark should function and to develop the performance requirements to be used in future product development and specifications. Should the participants of this workshop find that a directional feature is not necessary, specifications should ensure that the warranty/security mark (1) be visible on a license plate under laboratory or field conditions, (2) be verifiable in diffuse daylight and by retroreflective light at night, and (3) not alter the sheeting colors or graphic design or reduce sheeting brightness below the specified level.

SUMMARY AND RECOMMENDATIONS

A number of changes have occurred regarding how reflective sheeting is specified. One significant change was that an ASTM specification superceded Federal Specification L-S-300C in the late 1980s. However, the ASTM specification did not, and likely will not, include all of the test methods that are specified in Federal Specification L-S-300C. Virginia's license plate sheeting specifications should continue to reference the federal specification, when required, until such time as other consensus-based specifications can be updated.

As a result of the assessment, the Virginia Transportation Research Council is recommending that several changes be made to the license plate sheeting contract specifications. An overview of these changes includes:

- *Cold temperature resistance:*
 - Separate the impact test from the cold temperature resistance test.
 - Modify the current cold temperature resistance test to one that is more indicative of the temperature conditions a license plate may experience in Virginia.
 - Add a resistance to heat test that is indicative of the temperature conditions found in Virginia.
- *Solvent resistance:* Reduce the submersion time requirement for toluene, xylene, and methyl alcohol from 2 minutes to 1 minute.

- *Gasoline resistance:* Maintain a gasoline resistance test but modify the current test method to one that is more representative of how license plates might be exposed to gasoline.
- *ISO 9002 registration:* Modify the specification to allow Six Sigma to be an equal alternative to the ISO registration requirement.
- *Directional warranty mark:*
 - Continue to require an integral warranty/security mark that is indelible for the life of the license plate.
 - Retain the current warranty/security mark design.
 - Encourage the development and implementation of a consistent training course for Virginia's law enforcement community on the warranty/security mark found in Virginia's license plates.
 - Hold a one-day workshop with the Virginia State Police, the Virginia Sheriffs' Association, and the Virginia Association of Chiefs of Police to determine how the warranty/security mark should function and to discuss and develop performance requirements to be used in future product development and specifications.